Supplementary material for the study "Reef communities show predictable undulations in linear abundance size spectra from copepods to sharks" by F. Heather, R. Stuart-Smith, J. Blanchard, K. Fraser & G. Edgar

S1 Linear vs. nonlinear size spectra models

A linear model (Equation S1.1) was fitted to the size spectrum data within each survey site (s). The residuals of these fits were used to re-create Figure 3 (main text), and also to compare the goodness-of-fit to the nonlinear size spectrum fits.

$$log(N) = \beta_{0,s} + \lambda_s \cdot log(M) \tag{S1.1}$$

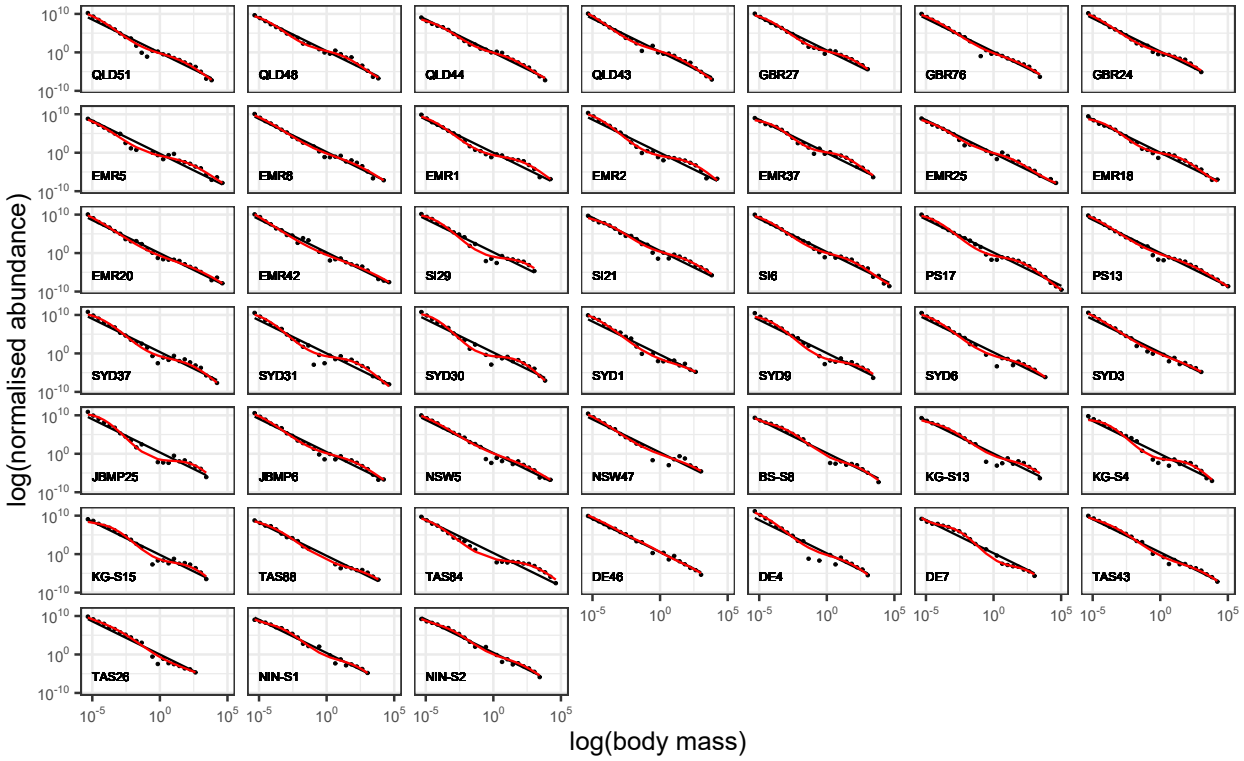

Figure S1.1: Continuous abundance size spectrum spanning 11 orders of magnitude in body mass, with a fitted linear model (black, Equation S1.1) and nonlinear model (red, Equation 1 in main text).

We also fit a single linear model to all sites, to answer the question about how much variability in abundance is explained by body size alone (at all sites)(Equation S1.2).

$$log(N) = \beta_0 + \lambda \cdot log(M) \tag{S1.2}$$

S2 Environmental variables

Table S2.1: Summary table of the environmental variables used in the study

Name	**Units**	**Details**
Mean sea surface temperature (SST)	°C	Bio-ORACLE (Tyberghein et al., 2012)
Phosphate	mmol l^{-1}	Bio-ORACLE (Tyberghein et al., 2012)
Nitrate	mmol l^{-1}	Bio-ORACLE (Tyberghein et al., 2012)
Mean Chlorophyll A	mg m^{-3}	Bio-ORACLE (Tyberghein et al., 2012)
Wave exposure	Categorical	(1) Sheltered, wind waves < 1 m
		(2) Waves 1 - 3 m
		(3) Ocean swell < 3 m
		(4) Open swell from prevailing direction
Currents	Categorical	(1) None
		(2) Weak
		(3) Moderate
		(4) Strong
Reef slope	Categorical	(1) < 1:10
		(2) 1:10 - 1:4
		(3) 1:4 - 1:2
		(4) > 1:2
Relief	Categorical	(1) < 0.5 m
		(2) 0.5 - 1 m
		(3) 1 - 2 m
		(4) > 2 m

S3 Body size position of peak abundance

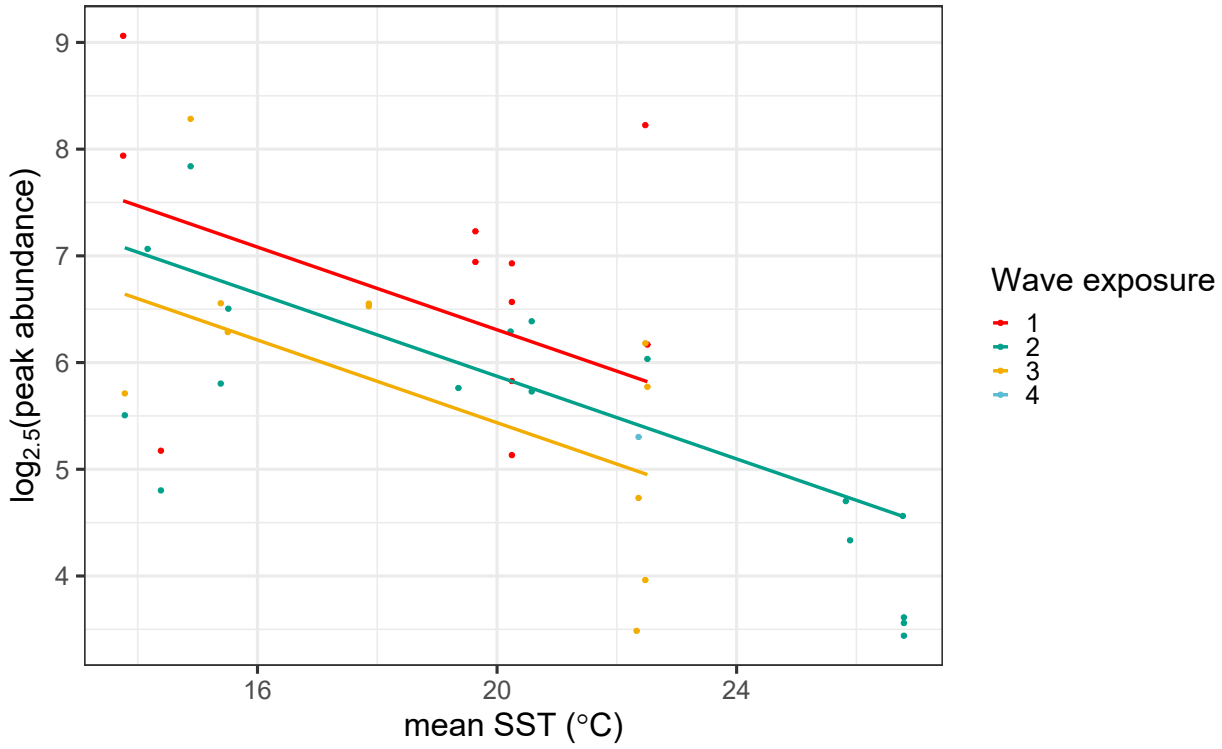

Figure S3.1: Relative peaks in abundance occur at certain body sizes in the size spectrum. These peaks in abundance can be predicted by wave exposure and SST (R^2 = 41%, Table S4.1). No line of best fit is shown for wave exposure = 4 as this group contained only one site.

S4 Linear models relating environmental covariates to model parameters

We used a combination of visual inspection and multivariate linear models to determine the environmental drivers (S1) of the variation in the five nonlinear model coefficents (β_0, λ, A, D, and position of peak abundance). We fit six maximal linear models, one linear model for each nonlinear model coefficient as the response variable, and with the environmental variables as predictor variables, to identify those covariates with a significant effect ($P < 0.05$) on the specific model coefficient. Simplified models, containing only those significant

variables can be seen in Table S4.1. The phase parameter (P) was excluded as did not represent a meaningful feature of the nonlinear model when the wavelength (D) is not fixed (see main text).

Table S4.1: Summary of the most important environmental variables explaining the variance each nonlinear model parameter and the amount of variation explained from a multiple linear regression.

Parameter	**Predictor variables**	$\mathbf{R^2}$
Wavelength (D)	Reef slope	13%
Amplitude (A)	Reef slope	25%
Slope (λ)	Wave exposure, SST	34%
Peak abundance	Wave exposure, SST	41%

References

Tyberghein, L., Verbruggen, H., Pauly, K., Troupin, C., Mineur, F. and De Clerck, O. (2012), 'Bio-ORACLE: a global environmental dataset for marine species distribution modelling: Bio-ORACLE marine environmental data rasters', *Global Ecology and Biogeography* **21**(2), 272–281.

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